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INFORMATION REPORT

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COUNTRY East Germany

REPORT

SUBJECT VEB Funkwerk Koenig: Development of Antenna Measurement Devices

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1. From 1952 to late 1954, Department TEA (Technical Development of Antennae) of VEB Funkwerk Koenig performed research and development work on antennae measurement devices. This work was done first under the supervision of Dr. Erich Schuettloeffel and, after his defection in 1954, under Eng. Horst Geschwinde. The work reported on below was mostly carried out by Eng. Rolf Gruss, a physicist, with the assistance of Kuehn (fnu), who is responsible for mathematical work in the department.

a. Impedance measurement unit.

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The task was to develop an impedance measurement unit for the measurement of short-wave antenna impedance in the frequency range from 3 to 20 mcs. The measurement range was to cover up to 1,000 Ohms for the real and up to 500 Ohms for the imaginary (blind) component. Development of the device was thought to be technically important for antenna investigations since routine devices so far in use (conductance measurement units, Leitwertmesser) could not be used because of their small diagonal voltages. The task was fulfilled by the use of the so-called substitution method, i.e. the comparison of mistuning and attenuation (see figure 1 of Annex 1, representing a circuit diagram with the letter designations mentioned here). The antenna circuit is tuned to the measurement frequency with the aid of the rotary condenser  $C_1$  while the switches  $S_2$  and  $S_3$  are in short-circuit position. Through operation of the Switch  $S_1$  and tuning of the comparison circuit with the aid of the rotary condenser  $C_2$  the same voltage will be measured at L in either position of  $S_1$ . The antenna which is the subject of the measurements is then connected. Mistuning and attenuation are compensated with the aid of  $C_2$  and the resistance standard  $R_N$ . The capacity of the antenna can then be computed from the relation

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$$C_V = \frac{C_{A1} \cdot C_{A2}}{C_{A1} + C_{A2}}$$

to be

$$C_{A2} = \frac{C_V \cdot C_{A1}}{C_V - C_{A1}}$$

If the value is positive, the impedance is capacitive; if the value is negative, the impedance is inductive. Since the capacity of the rotary condensers is not in direct proportion to the frequency, and since the influence of the circuit capacity as well as the capacity of the resistance standards ( $R_N$ ) considerably disturbed the measurements, it was necessary to use correction curves. Another difficulty in the practical operation was the fact that two circuits had to be exactly symmetrical. In addition, the switch  $S_1$  had to have a faultless contact. The final output of the measurement antenna had to be at least 200 watts so that the extraneous voltages (Fremdspannung) would not exceed 10% of the voltage of the tube voltmeter. The device was completed in 1953. An accuracy of plus or minus 3% of the impedance value of the antenna was reached. It was planned to extend the development in the future to medium-wave and long-wave antennae.

b. The "Mine" Device

The device called "Mine" developed during 1953 was for the measurement of the mismatching (Fehlanspassung) of UKW\* antennae and filter circuits in the frequency range from 30 to 300 mcs. The device was to replace the measurement circuits (Messleitungen) so far used, which had a length of about 2.50 meters and therefore were unhandy and could not be easily used in field work. The dimensions of the Mine device were to be as small as possible. The task was tackled by the use of the so-called bridge method (Brueckennmethode). The method was based on comparison with a resistance standard whose mismatching factor was smaller than 1.03 in the frequency range up to 300 mcs. Two resistance standards were constructed, one with a characteristic impedance (Wellenwiderstand) of  $Z = 60$  Ohms, and the other one with  $Z = 70$  Ohms. The circuit diagram and a diagram of the mechanical construction are represented by figure 2 of Annex 1 and figure 3 of Annex 2. Difficulties were experienced with the diode tube voltmeter. The input capacity was too great, and consequently the diagonal voltage could not be reduced to zero. The first experiments were made with Telefunken tube type SA 101 and its East German imitation, type EA 904, delivered by VEB Funkwerk Erfurt; also with old Wehrmacht type LG1. The final model was equipped with germanium diodes from the Sueddeutsche Apparatefabrik in West Germany. The measurement procedure consisted of the following steps: The diagonal feed voltage (Brueckenspeisung) was measured and adjusted to the red standard mark of the scale. The tube voltmeter was then commuted to the diagonal voltage  $U_D$  and the reflection factor  $m$  could be read directly from the scale due to the relation

$$m = \frac{U_E - U_D}{U_E + U_D}$$

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\* Ultra short wave

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where  $U_B$  stands for the bridge feed voltage and  $U_D$  for the diagonal voltage. The accuracy reached was plus or minus 2% of  $m$ . This accuracy is greater than the accuracy obtained with the routine measurement circuits, which even under favorable conditions work with an error of at least 5%. Through measurement of the voltage  $U_B$  (see figure 3 of Annex 2), it could be determined whether the resistance causing the mismatching was greater or less than 60 Ohms.

c. Reflectometer

This device, which was completed in 1954, was to be used as a control installation during transmissions for measuring the matching (Anpassung) of transmitter and antenna. For this purpose it was to be included in the power line. The prescribed range was from 30 to 300 mcs. Characteristic impedance (wave resistance) of  $Z = 60$  Ohms was also prescribed. At first a laboratory model was completed; later several models for higher output up to 10 kw were constructed. The task was tackled in accordance with the reflectometer principle through comparison of the induced voltages of two loops inserted into the circuit. If there was matching, there was no stationary wave due to total power transfer. If there was mismatching, the original and the returning wave caused a voltage difference in the loops, which was measured. A circuit diagram of the reflectometer is represented by figure 4 in Annex 2. The reflection factor  $m$  was computed from

$$m = \frac{U_H - U_R}{U_H + U_R}$$

where  $U_H$  stands for the voltage of the original wave and  $U_R$  for the voltage of the returning wave. The first experiments were made with one loop only, but the sensitivity reached was much too small. The two-loop model was subjected to trial operations with the UKW transmitter in Rheinsberg and showed very good sensitivity. The accuracy range with the two-loop model was around 5% of the scale deflection.

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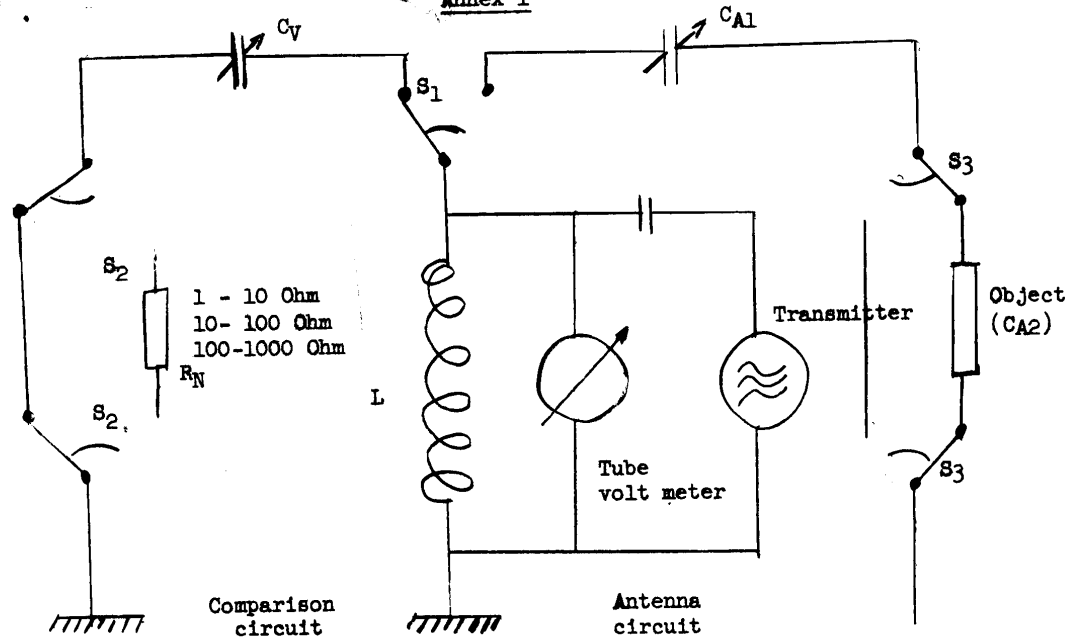
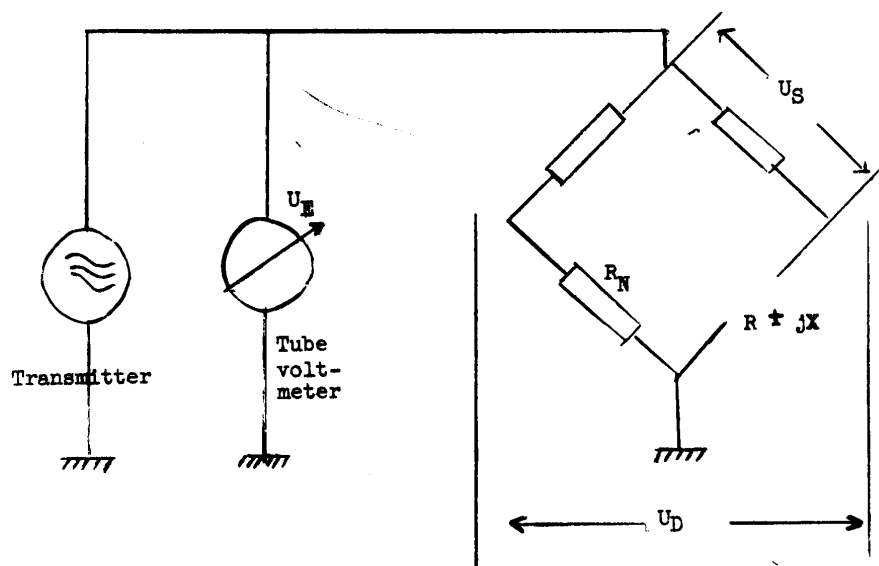
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Annex 1

Fig. 1 Impedance measurement unitFig. 2 Mine device

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Annex 2

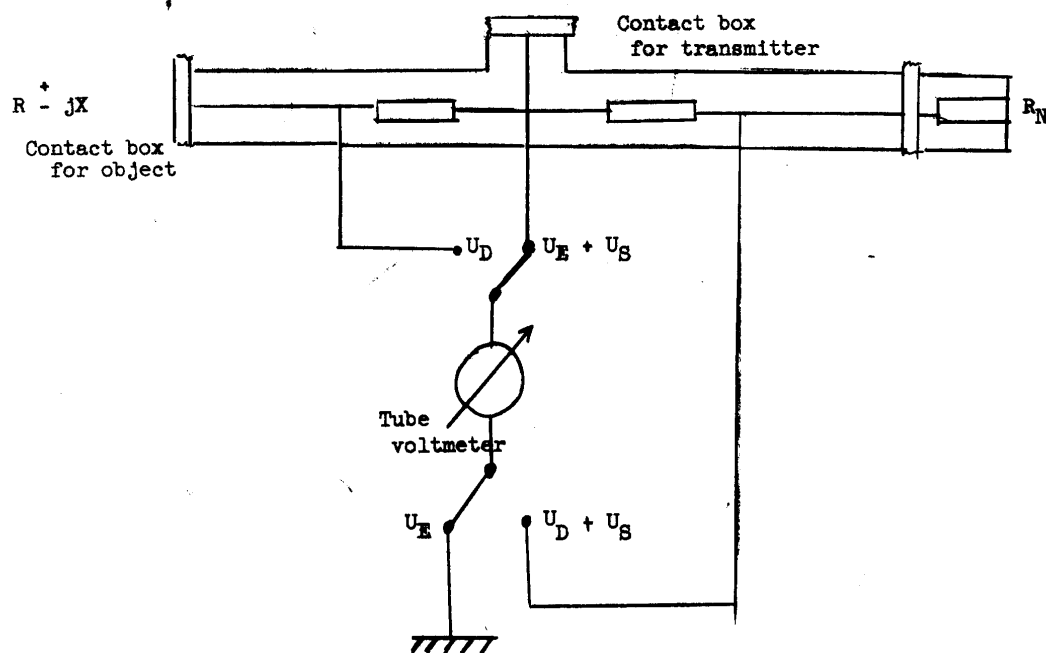


Fig. 3 Construction diagram of Mine device

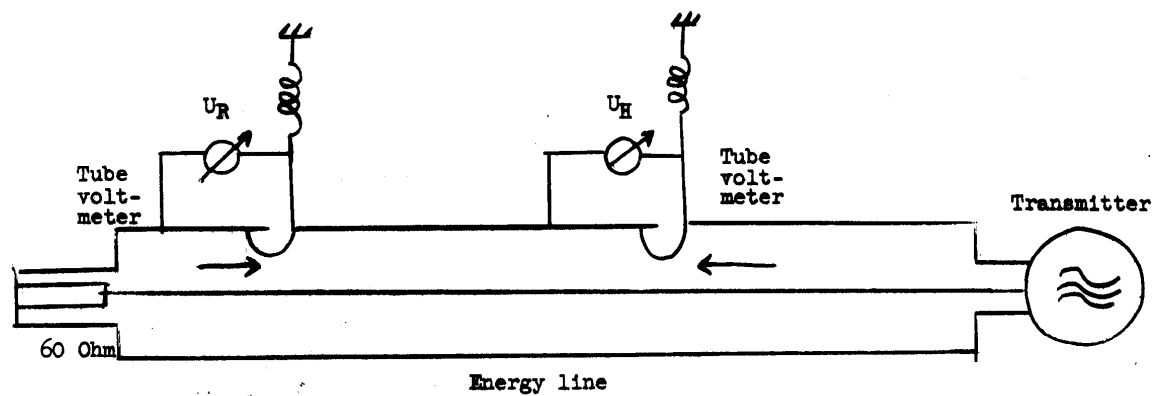


Fig. 4 Reflectometer

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